



CHAPTER 7
NATIONAL AIRSPACE SYSTEM
MODERNIZATION

7 National Airspace System Modernization

NAS modernization has been designed as an evolutionary process that will sustain current NAS operations while new technologies are introduced, proven, and then deployed. This process will allow for a smooth transition from one technology to another, provide sufficient time for users to equip their aircraft with the avionics required to take advantage of the new technologies, and realistic schedules for the FAA to test, train for, and deliver services.

NAS modernization is an ongoing process that builds upon the implementation of individual projects to improve the effectiveness of the entire NAS. The events of September 11 have understandably shifted the focus of the aviation community from congestion and capacity enhancement to security. But despite the decrease in traffic in the last year and forecasts for a gradual rebound, long-term forecasts still call for a large increase in demand over the next decade. NAS modernization, and the capacity enhancement that it will provide, remains a vital task of the FAA and its partners. In this vein, important work on NAS modernization continued during the past year.

7.1 Wide Area Augmentation System

The Wide Area Augmentation System (WAAS) is a supplement to the basic Global Positioning System (GPS) signal that increases the accuracy, availability, and integrity of the signal. The FAA intends to provide time efficiencies and cost savings through satellite-based navigation implementation. This technology allows direct point-to-point navigation, optimum routing, and other capacity improvements. Efficiencies and savings realized by the airlines, the traveling public, and the FAA include:

- Increased air traffic control efficiencies and NAS capacity through an airspace system that is restructured to accommodate direct routings between airports, as well as reduced separation standards.
- Reduced fuel cost to airlines and reduced travel time to the public through use of more economical air routes.
- Reduced FAA operating costs through the potential decommissioning of part of the existing ground-based navigation system.

The WAAS signal-in-space continues to provide accuracies well within the range required by the WAAS specifications and coverage availability over most of the continental United States. Recent accomplishments include developing WAAS interference mitigation and rejection methods; developing a safety processor to meet FAA safety assurance standards; and conducting ionosphere data collection and analysis to define WAAS final operational capabilities. Proposed activities for the near future include refining WAAS performance and assessment capabilities; developing interference detection and mitigation techniques; and analyzing the impact of additional civil GPS frequencies.

WAAS is projected to become operational in 2003, providing LPV (localizer performance with vertical guidance) approach minimums of 250 feet. An important benefit of LPV will be bringing vertically-guided instrument procedures to several thousand runways that would not normally have an instrument approach, many of which serve general aviation users. Sometime between 2009 and 2015, WAAS is expected to provide ILS-like Cat I approaches to 200-foot decision altitude and one-half mile visibility at most U.S. airports.

7.2 Local Area Augmentation System

The Local Area Augmentation System (LAAS) is an additional augmentation of GPS that will provide highly accurate navigation signals to suitably equipped aircraft. The LAAS program was designed as a collaborative project between the FAA and the private sector. During the past year this approach has made significant advances towards the implementation and actual use of this advanced navigation and guidance system. FedEx has been the leading participant in this effort and has conducted a number of successful trials at its Memphis base. LAAS should provide the following efficiencies and cost savings:

- An increased number of instrument approaches, extending all-weather service to a greater number of cities and reduce traffic complexity resulting from back-course approaches and circle-to-land operations.
- Lower landing minimum, improving on-time performance by reducing the frequency of flight disruptions such as missed approaches, diversions, delays, and cancellations.
- Increased number of approaches with vertical guidance and improving safety by reducing the risk of controlled-flight-into-terrain accidents.
- Increase navigation accuracy and flexibility and improve traffic efficiency by facilitating more effective NAS configurations and optimized fuel/time navigation solutions.

LAAS is intended to complement WAAS; the systems will function together to supply users of the NAS with seamless satellite-based navigation for all phases of flight. LAAS will be used to meet Cat I precision approach requirements at those locations where the accuracy correction signals from WAAS geostationary satellites may not be fully reliable (e.g., in mountainous areas). LAAS will also be used to meet the more stringent Category II/III requirements at selected locations throughout the U.S. LAAS will yield the extremely high accuracy, availability, and integrity necessary for Cat II/III precision approaches, at one meter or less.

7.3 Standard Terminal Automation Replacement System

The Standard Terminal Automation Replacement System (STARS) is a joint FAA and Department of Defense program to replace Automated Radar Terminal Systems (ARTS) and other capacity-constrained, older technology systems at 74 FAA and up to 199 Department of Defense terminal radar approach control facilities and associated towers.

Controllers will use STARS to provide air traffic control services to aircraft in terminal areas. Typical terminal area air traffic control services include: the separation and sequencing of air traffic, the provision of traffic alerts and weather advisories, and radar vectoring for departing and arriving traffic. The system will reduce the life-cycle cost of ownership, accommodate air traffic growth, and provide for the introduction of new automation functions that improve the safety and efficiency of the NAS. One of the key features of STARS is that FAA will be able to upgrade the software to provide new air traffic control tools.

The STARS program has been significantly revised since its first definition in 1996. It was originally designed to use off-the-shelf technology, with little specialized software

development. However, in consultation with the air traffic controllers and the airways facilities maintenance technicians, who raised a number of concerns about the computer-human interface, the FAA concluded that it needed to develop a more customized system and to implement it incrementally. In March 2002, the FAA reduced the number of facilities that will be receiving STARS from 188 to 74 and changed the date to complete installation at all of those facilities from 2005 to 2008. The date for deploying the full STARS to the first location is still 2002. Limited versions of STARS are already installed in El Paso, TX; Syracuse, NY; Memphis, TN; Hartford, CT; Birmingham, AL; Albuquerque, NM; Detroit, MI; Albany, NY; and Providence, RI.

The first full STARS deployment took place at the Philadelphia terminal control facility on November 17, 2002. The FAA will use STARS to control live traffic, which is considered initial operating capability, but will retain the existing air traffic control system as a backup until the new system is formally commissioned.

7.4 HOST Software Rewrite

In 1999, the hardware for the air traffic control system was successfully replaced. The HOST and Oceanic Computer Replacement program replaced the interim computers that had served the ATC system from the mid-1980s to the present. However, the basic en route center automation system, which receives, processes, coordinates, distributes, and tracks information on aircraft movements throughout the nation's airspace, is based upon the original, often modified, software. Those programs were written in a computer language, JOVIAL, that is not widely used now and therefore are difficult to upgrade to accommodate new requirements.

The FAA is developing the En Route Automation Modernization (ERAM) program to replace the current NAS software and to add the capabilities required to support NAS modernization. ERAM will provide an open standards-based system that will incorporate commercial off-the-shelf and non-developmental items as much as possible. ERAM will make it easier to integrate new capabilities into the system, reduce the training needed to maintain the system, and offer enhanced simulations. The FAA has selected a team to begin the ERAM program and the final specification is under development.

7.5 Free Flight Phase 1

Free Flight Phase 1 (FFP1) Core Capabilities Limited Deployment initiative was designed to deliver early benefits of free flight to NAS users while mitigating the risks of implementing new technologies. The FFP1 program has been successfully implemented at all of its initially planned sites and has been extended to others. In addition, the new technologies are bringing real and measurable improvements, as summarized below.

User Request Evaluation Tool

User Request Evaluation Tool (URET) is operational at six centers: Kansas, California, Memphis, Indianapolis, Cleveland, Chicago, and Washington (Leesburg). Both facilities are providing increased direct routings to users, resulting in savings in aircraft direct operating costs of \$1.5 million per month. Also, the Indianapolis Center has eliminated more than 22 altitude restrictions, saving users nearly \$1 million per year in fuel costs. URET is being deployed at five additional centers.

Traffic Management Advisor

The Traffic Management Advisor (TMA) is fully operational at three centers, providing metered traffic flows to the Dallas/Ft. Worth, Denver, and Minneapolis airports. In addition to more fuel-efficient flows, TMA has increased peak capacity at these airports by 2-to-5 percent. Additional TMA systems are deployed at centers feeding traffic to Atlanta, Los Angeles, San Francisco, and Miami airports, where the controllers use TMA to provide increased situational awareness, leading to more efficient traffic flows.

Surface Movement Advisor

The Surface Movement Advisor (SMA) was the first Free Flight Phase 1 program to be completed. Feedback from the airlines has been very positive; Northwest Airlines has estimated that it has been able to avoid three-to-five costly diversions weekly, especially during periods of inclement weather. Four additional airlines are currently using SMA data to improve operations.

Collaborative Decision Making

Both a philosophy of traffic management and an array of computer tools that facilitate a real-time collaboration between the FAA, and the airlines, Collaborative Decision Making (CDM) provides FAA traffic flow managers and airline dispatchers with the same real-time information. It links the FAA with the dispatch systems of the airlines and provides the airlines with access to NAS data, including weather, equipment, and delays. CDM allows the FAA to manage the air traffic system more efficiently and the airlines to employ their aircraft more effectively.

7.6 Free Flight Phase 2

Free Flight Phase 2 (FFP2) builds on the successes of Free Flight Phase 1 to improve safety and efficiency within the NAS. FFP2 includes the east-to-west expansion of Phase 1 elements, including URET and TMA, to additional FAA facilities. FFP2 will provide incremental enhancements to URET and TMA during the period 2003-2005. FFP2 will deploy a number of additional capabilities.

One of the Phase 2 initiatives, Controller Pilot Data Link Communications (CPDLC), achieved initial daily use on October 7, 2002, in Miami Center airspace. CPDLC provides a method of communication between the air traffic control facility and the aircraft cockpit through the digital transmission of messages, eliminating a great deal of voice traffic, thereby reducing congestion on radio frequencies.

Additionally in Phase 2, the FAA (and its collaborators) will conduct selected research activities to extend certain FFP1 capabilities and to develop others. Research activities in FFP2 include the Multi-center Traffic Management Advisor, the Surface Management System, and two controller routing and conflict resolution aids, the Direct-To-Tool, and the Problem Analysis, Resolution and Ranking (PARR) function.

7.7 Ohio River Valley Project

The Ohio River Valley (ORV) project is a government/industry initiative to demonstrate and validate the capabilities of advanced communications, navigation, surveillance, and air traffic control procedures to increase the capacity and efficiency of the NAS. This initiative

is another step in the evolutionary process of bringing emerging technologies into the NAS. The Ohio River Valley project addresses issues connected with fielding advanced systems such as Automatic Dependent Surveillance-Broadcast (ADS-B), Controlled Flight Into Terrain (CFIT) avoidance, and the Traffic Information Service-Broadcast (TIS-B). The Ohio River Valley project evaluates the following issues:

- Addresses pilot and controller human factors issues.
- Develops and assesses new operational procedures and the associated training.
- Streamlines certification processes and procedures.
- Develops a cost-effective avionics and NAS infrastructure.
- Defines a realistic NAS transition path that is supported by the user community

The Ohio River Valley project is testing ADS-B avionics on commercial cargo aircraft in the Ohio River Valley. These tests are taking place in terminal areas with significant cargo operations, including Memphis, Tennessee; Wilmington, Ohio; Louisville, Kentucky; Scott Air Force Base, Illinois, and Nashville, Tennessee. The Ohio River Valley Project is co-sponsored by the Cargo Airline Association (CAA) and the FAA. The CAA has purchased, equipped, and is maintaining the avionics for the test aircraft. The CAA members are conducting revenue flights with these aircraft to evaluate the systems' performance in normal operations.

The FAA has purchased, installed, and is maintaining ground systems at the five sites. A ground broadcast server has been installed at the Wilmington site that receives data from the other sites and depicts ADS-B targets fused with radar targets. As the project proceeds, fused ADS-B and radar target data will be made available to suitably-equipped aircraft to enable the pilots to see both targets on a cockpit display, along with selected broadcast information such as weather maps, special use airspace status, and wind shear alerts.

As part of the ORV project, the project has established or modified operational concepts and procedures, including departure spacing, runway and final approach occupancy awareness, and airport surface operational awareness. These initiatives are for demonstration purposes only at this time. In addition, the project installed a special Common ARTS automation system at the Louisville TRACON for evaluation by controllers in their work with airborne ADS-B applications and has installed a multilateration ADS-B surface surveillance system at Memphis in order to conduct an evaluation of surface management. That evaluation was completed in 2001.

As the ORV project continues, the FAA and the industry will share the funding of avionics and ground systems to build on ongoing industry initiatives. These include resolving ADS-B technology issues; continuing extensive data collection activities during operational evaluations; exploring the use of TIS-B and FIS-B data link messages to receive traffic and weather information in the cockpit; and developing an integrated cockpit display of terrain, traffic, and weather conditions. Throughout the project, the FAA will take special care to ensure that controllers and both commercial and general aviation pilots are included in the evaluation of operational enhancements and data link alternatives.

7.8 Alaska Capstone Program

The Capstone Program was established by the FAA as part of its Safer Skies initiative, in response to a National Transportation Safety Board (NTSB) safety study, Aviation Safety in Alaska, to address Alaska's high accident rate for small aircraft, which is five times the national average. A recent FAA-sponsored study estimated that 38 percent of commercial operator accidents in Alaska could be avoided if information on position relative to terrain and real-time weather information were available to pilots in the cockpit. The principal objective of the Capstone Program is to improve pilots' situational awareness of the flight environment and to thereby avoid mid-air collisions and controlled flight into terrain. Although the FAA plans to initially demonstrate the benefits of these technologies in Alaska, it will eventually consider extending those technologies to the entire NAS.

Capstone is a joint government/industry initiative designed to prototype, demonstrate, validate, and implement the capabilities of advanced surveillance systems and air traffic procedures, using Automatic Dependent Surveillance-Broadcast (ADS-B), Flight Information Services-Broadcast (FIS-B), and Traffic Information Service-Broadcast (TIS-B) as enabling technologies.

The Capstone initiative is a visible program providing tangible benefits. Capstone is building an infrastructure that is consistent with NAS modernization plans and it is identifying the transition path for procedure development and technology implementation while providing near-term safety benefits. Capstone's first priority is to improve aviation system safety in Alaska through the introduction of new communications, navigation, and surveillance technologies.

The FAA has equipped 120 commercial aircraft in a non-radar environment in the Yukon-Kuskokwim Delta region of southwest Alaska with the Capstone avionics suite. It includes a cockpit multifunction display, a GPS navigation/communications unit, a Universal Access Transceiver data link unit, and a GPS-based terrain database of Alaska. The suite enables each participating aircraft to broadcast its identification, position, and altitude, climb rate, and direction and to receive similar signals from other aircraft.

The FAA has begun the installation of a network of data-link ground stations that will transmit radar targets of non-participating aircraft to the Capstone aircraft. In addition, the ground stations will transmit flight information services, including weather reports and forecasts, maps, status of special use airspace, pilot reports, and notices to airmen. The FAA is also publishing non-precision approaches and installing automated weather observation systems at 10 village airports in the Delta region.

The initial improvements of Capstone are directed towards pilots conducting Visual Flight Rule (VFR) operations. In the future, the FAA plans to certify systems and equipment and develop enhanced operational procedures for Instrument Flight Rule (IFR) operations. When this is accomplished, ADS-B can be used for air traffic control functions just as radar is now used. Specific accomplishments of the Capstone Program in Alaska include the following:

- Initiated the use of ADS-B at the Anchorage center with a single ground-based receiver to provide radar-like services in the Bethel, AK area.
- Installed eight operational ground-based receivers in the Yukon-Kuskokwim Delta region of southwestern Alaska.

- Installed and commissioned nine Automated Weather Observation Systems with weather cameras.
- Published 19 first-time GPS approaches for 10 Alaskan airports.
- Trained over 100 pilots and associated personnel on Capstone avionics.
- Demonstrated the incorporation of WAAS technology with Capstone avionics in southeast Alaska.

Additional developments in Capstone are planned to continue through the rest of 2002 and during 2003. These include the installation of Capstone avionics in additional participating aircraft in southeast Alaska, the installation of ADS-B ground-based transceivers in Bethel and southeast Alaska, and evaluations of these and earlier actions.

7.9 Summary

NAS modernization continues on the successful path that has been established in the past several years. The current decline in aircraft operations gives the FAA and the aviation community a rare opportunity to accomplish many of these activities without the press of heavy congestion. Although the financial difficulties of the aviation industry may delay the equipage of some aircraft with the avionics required to take advantage of many of the FAA's NAS modernization activities, in the longer term these are likely to be accomplished, in part because many of these new technologies offer substantial near-term benefits and because they are important steps in the continuing evolution of the system to one of Free Flight.